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Cast-iron Die Castings

It is now possible to reveal that during the war, nine Eaton-Erb continuous cast-iron die-casting machines have been introduced into this country. Four of them are installed in the works of Qualcast, Limited, of Derby, where they are making 250 tons of a wide variety of castings per week. The undoubtedly successful outcome of this enterprise is due to the interlocking of a series of techniques. The construction of the dies and their maintenance at a constant temperature; the coating of the dies; the speed of operation, and the chemical and physical properties of the metal. There was throughout the initial stages the closest co-operation with the Detroit foundry of the Eaton-Erb concern. Fundamentally there was a difference, as British plants are expected to use high-phosphorus iron. However, this has proved to be an advantage rather than a drawback. The process, in very general terms, consists of mounting a number of dies on the periphery of an 18-ft. dia. table, capable of being rotated at speeds varying from 1½ to 9 min. for one revolution, depending, of course, on the type of casting being made. The moulds are filled from hand shanks at the pouring station; the dies open mechanically, and the castings are extracted at the second position; they are next subjected to the action of a series of acetylene flames, which automatically come into action when the die is in position and shut off after its passage to the next station. Here the die is cored-up if necessary, then closed, and is ready for the next cycle. To maintain a proper temperature the dies, which are about ¼ in. thick, carry on their reverse side many dozens of projecting needles. Moreover, in suitable positions, there are vents so that in their passage round the circuit they are subject to a cooling effect through the operation of a 40 h.p. fan mounted in a pipe situated centrally over the table.

Mr. J. E. V. Jobson, chairman and managing director of Qualcast, Limited, who conducted us around the new plant, is satisfied that in the future there is a definite well-defined field for the successful prosecution of this process. The die-life has been constantly showing improved results, and, with a mould carrying two castings, no fewer than 44,000 castings were made. The wartime experience of making millions of incendiary bomb noses and smoke bombs, and other ammunition, has afforded ample opportunity to assess the true manufacturing capabilities of the process. The percentage of wasters is extremely small, which once again focuses attention on sand as being a major factor in the production of defective castings. Once the dies have been made and tried out—and for this purpose there is reserved a special floor at the side of the machines—then the rate of production is extremely high—higher than any other moulding layout we have so far seen. All sand costs are eliminated—except for cores; fettling costs are at a minimum; but there is the extra expense of annealing. Machining is likewise at a minimum. The cost of making dies is high, but where quantity is concerned, the making of a master pattern is not negligible! We have seen one made for an air-cooled cylinder during the first world war which cost over £2,000, and one made for the Eaton-Erb process on which only £10 was spent. Thus for the success of this process, designers must finalise their ideas, so that really large orders can be placed.

For the ordinary grey-iron foundry to undertake the making of any form of cast-iron die casting—except for the simplest of shapes—we visualise endless troubles in the co-ordination of the various techniques involved. By mechanisation, such as has been accomplished in the Eaton-Erb process, the many potential variables are easily controllable.

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CARBON-MONOXIDE RISKS

BLAST-FURNACE OPERATION

A Memorandum on "Carbon-Monoxide Poisoning" (revised edition), issued by the Factory Department, Ministry of Labour,* deals in one section with carbon-monoxide risks at blast furnaces, pointing out that each ton of iron produced by the blast furnace is accompanied by the evolution of approximately 6 tons of gas, so that enormous volumes have to be handled and disposed of safely.

With either hand-charged or automatic and self-charging furnaces, even under the best conditions some escape of gas is inevitable, and to reduce the risk of poisoning, any escaping gas should be ignited. In order to minimise the effects on the men engaged in the loading process, there should be ample working space to enable them to get to windward and to avoid puffs of gas as much as possible. Some gas may also escape from badly luted explosion relief doors and be blown across the working platform. The Memorandum depicts a form of explosion relief door housing with a well-machined face, which is self-closing and is claimed to be gas-tight. A further precaution is the provision of suitably placed wind shields to help in dissipating gas by making use of existing air movement. The case of the workman operating the furnace controls on the charging platform remains to be considered, as he cannot move about and take advantage of wind direction to avoid gas; it has been suggested that the controls and the operator should be situated in a cabin rendered gas-tight and provided with fresh air from a source remote from contamination by toxic gas.

Bulky Scrap Material

From time to time the charge may jam between the bell and feed hopper, thereby preventing the bell from closing, with the result that there is a copious escape of gas from the top of the furnace; many cases of gassing have resulted from this cause, including three out of five fatalities in recent years. The use of bulky scrap material, particularly in the form of bales, has been a contributory cause of this kind of accident during the war period. As regards self-charging furnaces, care should be exercised by any person who may have to ascend to the gantry on occasion to carry out maintenance work or other duties. In such cases men should not work alone, but should be accompanied by at least one other person as a precaution in case of gassing; some firms arrange to have a first-aid attendant available at the place of work.

A useful safety precaution against gassing adopted at several blast furnaces is the provision of compressed-air lines installed along the gantry to which breathing apparatus may be attached by flexible pipe lines at convenient points. The breathing apparatus consists of a simple face mask fitted with an expiratory valve, and may be kept in a suitable cupboard near the gantry ready for immediate use. Should an escape of gas occur, the breathing apparatus is donned and connected *via* the pipe to the compressed-air supply, which effectively flushes out the mask with pure air and prevents any inhalation of gas. The flexible pipe connection allows excellent freedom of movement. A layout of the apparatus is illustrated in the Memorandum.

* H.M. Stationery Office, York House, Kingsway, London, W.C.2. (Price 6d.)

PUBLICATIONS RECEIVED

"Books, Publications and Patents of Batelle Memorial Institute—1929-1944." Compiled by Thelma R. Reinberg and published by the Institute from Columbus, Ohio, U.S.A.

This 72-page brochure lists 819 books, publications and patents published or obtained by the Institute during the 15 years it has been serving, not only American industry, but the world at large. This is the concrete result of an organisation which was endowed as to buildings and equipment by a philanthropist, but which relies on the co-operation of industry for the financing of individual researches. Included are some 30 Papers on various aspects of cast iron, quite a few of which have been published in THE FOUNDRY TRADE JOURNAL. The system has always appealed to us as being essentially practical, and no one can examine the book without agreeing with us. The indexing has been particularly well carried out.

"Services Schedule of Non-ferrous Metals and Alloys. Group 6. Aluminium and its Alloys." Issued for the Ministry of Supply by the British Standards Institution, 28, Victoria Street, London, S.W.1. Price 1s., post free.

This excellent document lists and details a large number of both cast and wrought aluminium alloys standardised by the Services in relation to the specification numbers. In this connection the reviewer, whose memory for numbers is admittedly poor, registers a protest in normally bestowing on alloys a minimum of two designations. This is an additional nuisance, whereas in quite a few cases the specifications refer to alloys better known by their trade marks. For castings 15 specifications are detailed as to composition and mechanical properties, while later in the brochure their uses and other characteristics are set out in tabular form. Further notes form a preamble to the tables. These are of distinct use to the designer.

"The Stoker's Manual." Published for the Ministry of Fuel and Power by H.M. Stationery Office, Kingsway, London, W.C.2, and elsewhere. Price 6d. net.

This 88-page book is divided into five parts, four of which are essentially practical, whilst the fifth deals with the subject from an elementary theoretical aspect. The book can be thoroughly recommended for placing in the hands of the man in charge of any boiler—be it large or small. By following its precepts economies will result.

THE ANNEALING OF WHITEHEART MALLEABLE IRON BY A GASEOUS PROCESS*

Development of a practical and economical process on an industrial scale

By A. G. ROBIETTE, B.Sc.† (Member)

(*Continued from page* 260.)

Annealing Cycle

From a consideration of the fundamentals of diffusion as discussed in the foregoing section, it has been shown that the rate of decarburisation is mainly a function of temperature, and providing the decarburising medium is active to the extent that it will remove the carbon as rapidly as it is brought to the surface when the rate of decarburising (not necessarily the annealing cycle) is the same whether it is iron ore, CO/CO_2 mixtures, or H_2/H_2O mixtures. Why is it possible then to work a short-cycle process by using gas? The reasons may be listed in their order of importance:—(*a*) The heating and cooling cycles, as will be shown, are only a fraction of the times required in a packing process; (*b*) the temperature can be 70 to 100 deg. C. higher in the gas process (see Fig. 4 for the effect of this); (*c*) the gaseous decarburising medium never becomes spent as it may do in the ore process—it always has the maximum decarburising power; and (*d*) very little margin of safety need be allowed in assessing the time the castings are up to temperature.

The annealing cycle required for any particular range of castings depends upon what properties are required of the castings—in other words, what average carbon content is to be aimed at. For light-section castings having wall thicknesses of up to $\frac{1}{4}$ in., which form probably the bulk of whiteheart malleable castings, it is usual to aim at an average carbon content of less than 0.5 per cent. C. For light castings of $\frac{1}{16}$ to $\frac{1}{4}$ in. in section, then the average carbon content in the existing process is of the order of 0.08 to 0.20 per cent., with no free graphite. In other words, the process becomes a method of producing very light castings in what is, in effect, a dead mild steel—the carbon being removed in the solid instead of in the liquid state.

Castings above $\frac{1}{4}$ in. in section, and up to $\frac{1}{2}$ in., normally have an average carbon content of 0.2 to 0.5 per cent., with practically no free graphite. Heavier sections, up to $\frac{1}{2}$ in., contain an average carbon content of 0.6 to 0.9 per cent., with some free graphite in the middle of the section. For above $\frac{1}{2}$-in. thick section the amount of graphite in the centre of the section increases, and the average carbon content may increase up to about 1.8 per cent. C. Of this carbon the excess over about 0.9 per cent. is present as graphite, which takes the form of rosettes or spheroidal graphite, depending upon the Mn/S ratio. To produce the same results by the gaseous process operating at 1,050 deg. C., it has been found in practice, and the results are taken over a large number of tests, annealing charges varying in composition so as to represent a cross-section of the industry, that the following table can be taken to represent what is obtainable in average practice.

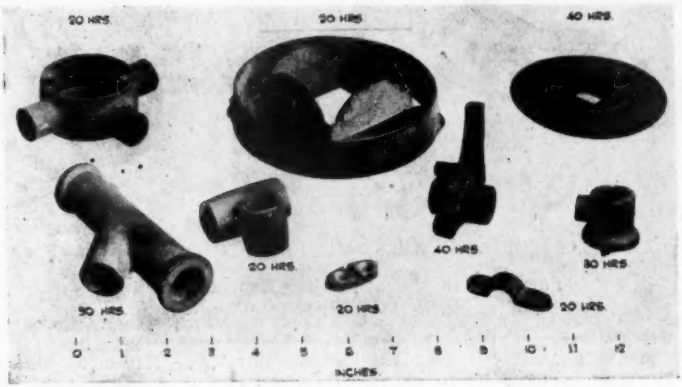

FIG. 7.—ILLUSTRATION OF GROUP OF CASTINGS ANNEALED FOR 20, 30 AND 40 HRS.

TABLE II.—*Annealing Time Related to Section Thickness.*

	Thickness of Casting in Ins.					
	$\frac{1}{16}$"	$\frac{1}{8}$"	$\frac{3}{16}$"	$\frac{1}{4}$"	$\frac{3}{8}$"	$\frac{1}{2}$" and over.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
Time required at temperature.. ..	10	16	24	36	40	48

* Paper presented at the 42nd annual meeting of the Institute of British Foundrymen, held in London, June 15 and 16, 1945.

† Consulting Metallurgist, H. A. Brassert & Company, Limited, (formerly, Chief Metallurgist, Birlec, Limited).

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It must be emphasised that Table II does not indicate the times required to produce the same degree of decarburisation in these sections. The Table gives the times required to produce approximately the same results as those at present being obtained in the existing process. It can readily be shown from the diffusion law that to obtain the same degree of decarburisation in varying thicknesses we should have a curve at 1,050 deg. C., as shown in Fig. 3. This curve was experimentally determined over a period of time, averaging the results of numerous compositions. It checks up closely with values calculated from the diffusion law expression.

Very few castings are completely uniform in section,

FIG. 8.—TYPICAL CASTINGS TESTED TO DESTRUCTION. TIME CYCLES 20 AND 30 HRS.

and it is common to have bosses of much heavier section which have to be machined. Should, therefore, the cycle be extended to cover the heavier sections, or will a cycle which deals with the average section be adequate? Each case must be judged on its merits, but, speaking generally, provided all the free carbide is broken down into graphite or pearlite, any heavy projections are readily machinable. The rate of breakdown of carbide is extremely rapid at 1,050 deg. C., and it depends first of all on the silicon content and also on the Mn:S ratio. With silicon contents of over 0.6 to 0.7 per cent., the carbide will graphitise in 20 to 25 hrs., but if it is as low as 0.4 to 0.45 per cent., it will not be decomposed until approximately 50 hrs. This assumes that there is no appreciable content of residual elements, such as chromium, present. High silicon contents of 0.8 to 1.0 per cent. will show complete breakdown in 5 hrs. These figures assume a Mn/S ratio of less than 1.7.

It will, therefore, be seen that, with normal analysis and a cycle of 24 hrs. or more at 1,050 deg. C., there is no difficulty in obtaining machinability in heavy sections, providing the silicon is over 0.6 per cent. Fig. 7 shows groups of castings annealed respectively for 20, 30 and 40 hrs. at temperature. The size of the castings can be judged from the scale at the bottom of the picture. Some of the same castings can be seen in Fig. 8 tested to destruction.

What affects the actual producer is the total time cycle. In the iron-ore process a common cycle for batch operation is 40 hrs.' heating, 100 hrs. at 950 to 980 deg. C., and 60 hrs.' cooling to 600 deg. C., making a total cycle of 200 hrs. This may be reduced to about 160 hrs. for thin-section castings, especially if annealed in continuous kilns. In some hand-fired furnaces the temperature may fluctuate considerably during the 100-hr. soaking period, due to irregular firing.

The heating time with good furnace design for an openly stacked charge of light castings in the gaseous process is of the order of 4 to 5 hrs., which may be increased to 6 to 7 hrs. for heavier castings. The circulating gases greatly assist heat transfer, whilst the absence of heavy boxes and a thermally insulating packing material make the difference between these times and those experienced in existing practice. Moreover, the furnace is normally charged at about 550 to 600 deg. C., *i.e.*, immediately a previous charge is withdrawn. Similarly, the cooling period is accelerated very considerably by forced cooling, and a cooling time of 8 to 10 hrs. from 1,050 deg. C. to below 700 deg. C. can be attained. This rather more rapid cooling results in a somewhat finer pearlite than that obtained by very prolonged cooling and may, depending upon carbon content, result in slightly higher Brinell hardness figures—generally about 130 to 140 B.H.N., as compared with 110 to 120 B.H.N. from the longer cooling.

This is not considered disadvantageous, as it increases strength and rigidity without appreciably affecting the ductility or machinability. In this latter connection, it has been found that there is less tendency to the production of hard spots (due to free cementite) owing to the more complete breakdown of carbide at the higher temperature. In fact, production castings have been annealed successfully with up to 0.25 per cent. Cr, which is found to cause difficulty in existing practice. Owing to the increasing tendency

TABLE III.—*Annealing Time Related to Section Thickness in the Gaseous Process.*

	Section Thickness in Ins.					
	1/16"	1/8"	3/16"	1/4"	3/8"	1/2"
Total cycle in hours ..	23	29	36	51	56	60

to the contamination of steel scrap with stray alloying elements, such as chromium and molybdenum, this feature is of particular importance. Reverting to the total cycle required in the gaseous process, Table III is a modification of Table II, with the heating and cooling times added to the time at temperature. Taking the whiteheart malleable industry as a whole, it is felt that a total average cycle of about 40 hrs. should be possible.

Test Requirements

The British Standard specification calls for a 45-deg. bend on a ½-in. thick flat bar; and a 5 per cent. elongation on 2 in. and an ultimate strength of 20 tons per sq. in. on a 0.564-in. dia. "as-cast" bar. The Author contends that these requirements are valueless unless the test specimen is related to the section of the actual casting. To illustrate this point, if a ½-in. test-bar is annealed with a batch of light castings, say small pipe fittings, then the residual carbon content of the latter will be, say, 0.2 per cent. or thereabouts in the gaseous process, whilst the test-bar will average 0.75 per cent. carbon. The position is as ludicrous as buying dead mild-steel strip, but calling for the test results of a high-carbon spring steel! Similarly, a standard tensile bar can give no indication of the properties of a 2½-in. thick casting which may, for instance, still contain free carbide. By far the most informative, though empirical, tests at present being carried out are tests to destruction, and it is mainly for the reason stated above that the Author has refrained from quoting any results on standard test-bars. Further, it is evident that, when light castings such as pipe, conduit and cycle fittings, are annealed by a short gaseous process of the order of 35 hrs., a standard

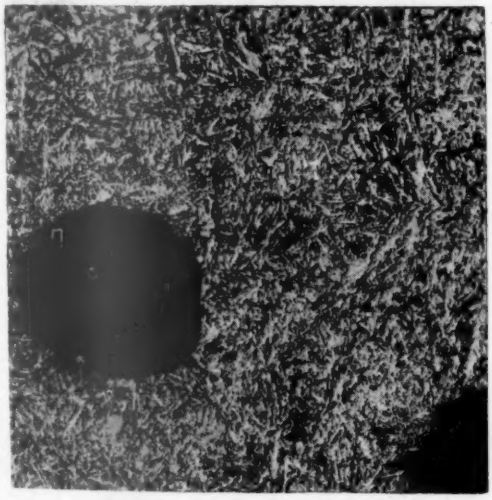

FIG. 9.—MICRO-SECTION SHOWING SPHEROIDAL PEARLITE IN GROUND MASS OF ACICULAR SORBITE. × 200.

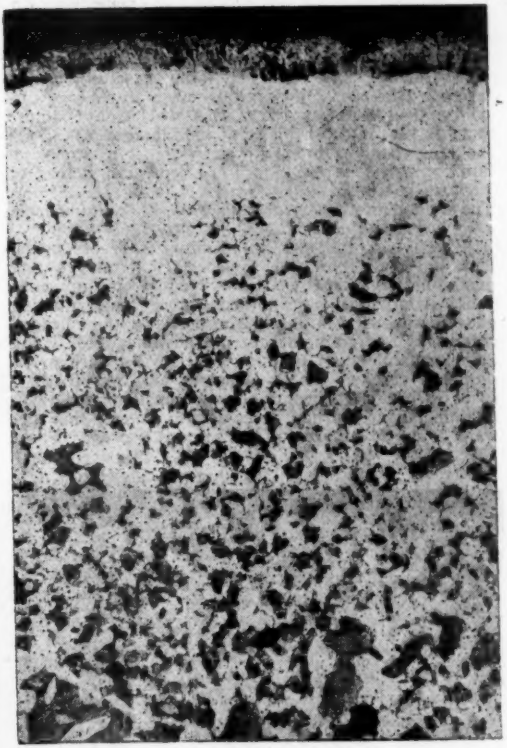

FIG. 10.—MICRO-SECTION OF NORMALLY DECARBURISED CASTING. × 60.

¼-in. bend test-bar contains far too high a carbon content to give the ductility attainable in the existing long-cycle process. The Author maintains, especially with the advent of the gaseous process, that a complete revision of test requirements is urgently required and that the test specimens should bear a close relation to the section of casting treated.

Moreover, what are the requirements for most engineering or hardware castings in whiteheart? In very few castings is the property of ductility or pliability required except that this property is sometimes used to reclaim castings distorted in annealing. The Author contends that for the large majority of engineering castings a product with a higher carbon content, and

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possibly one with the carbon in the form of some other transformation product of austenite, such as sorbite, would be better from a service point of view. For instance, a chain link would give greater strength, better wear resistance, together with adequate shock resistance, if the average carbon content were, say, 1.2 per cent. with a sorbitic structure and a Brinell of, say, 260 to 280. Similarly, take the question of a lever or a bracket. If decarburised to an average carbon content of 0.4 per cent., this article may fracture at a bend of 45 deg. with an applied load of 1 ton. On the other hand, a bracket with a higher average carbon content of, say, 0.75 will not bend until a load of 1.6 tons is applied, but the bend will only be 20 deg. The second product is obviously more desirable from a service point of view.

It would appear that a radical revision of current ideas on malleable iron is necessary to ensure that maximum advantage is taken of modern developments. What is more, it is incumbent upon foundrymen to educate the user so that he appreciates the changed conditions and to point out the advantages of being able to manufacture products which will give him the optimum results. These ideas are not put forward so as to be able to justify shorter annealing cycles by retaining higher carbon contents and putting this forward as an advantage for the gaseous process. From

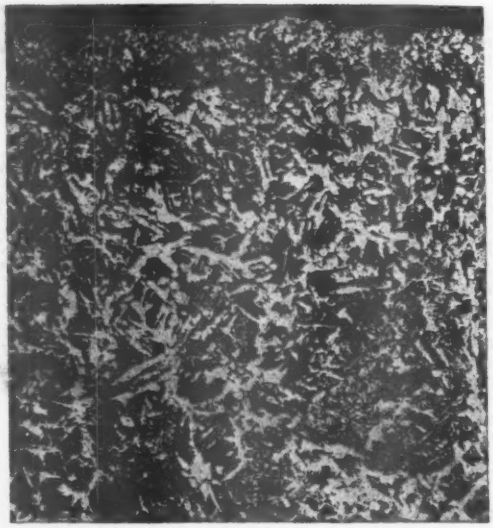


FIG. 12.—SAME CASTING AS FIG. 11, BUT GIVEN DIFFUSION TREATMENT. × 94.

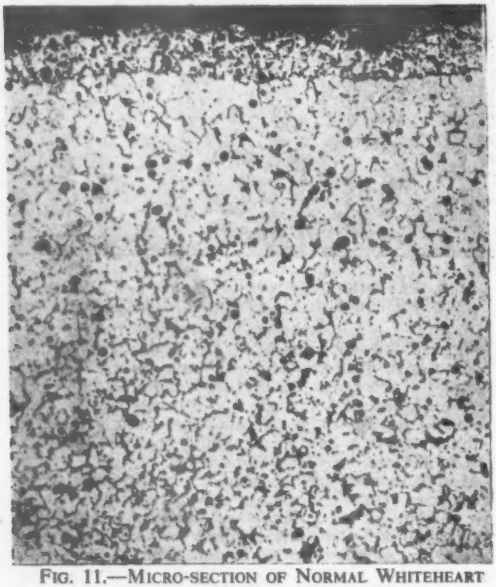


FIG. 11.—MICRO-SECTION OF NORMAL WHITEHEART CASTING (NORMALISED). × 94.

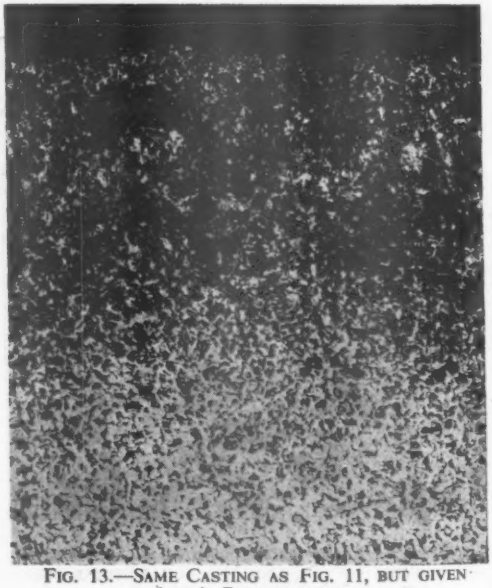
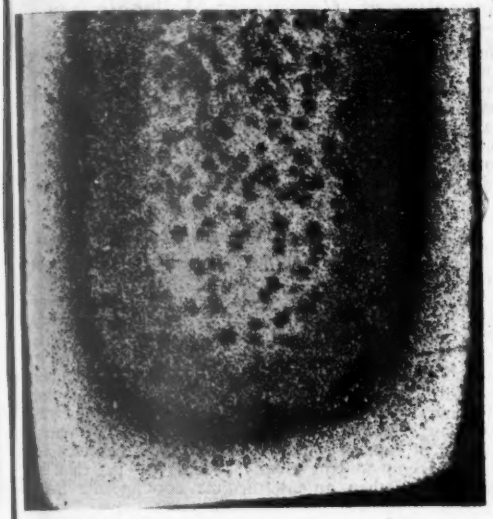


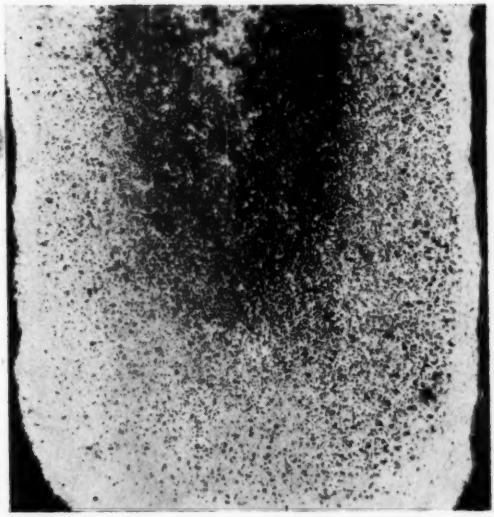
FIG. 13.—SAME CASTING AS FIG. 11, BUT GIVEN 1 HR.'S RECARBURISING.



(*a*)

(*b*)

(*c*)



(*d*)

FIGS. 14*a*, 14*b*, 14*c*, 14*d*.—MICRO-SECTIONS OF HIGH-MANGANESE WHITEHEART MALLEABLE ANNEALED FOR 24, 46, 70 AND 100 HRS. × 7.

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the figures quoted for comparative annealing cycles and the other benefits of gaseous annealing, the new process does not need this justification. All the Author contends is that, by getting more rapid breakdown of carbide, shorter cycles may in many cases result in a product which, with a short after-treatment, is similar to pearlitic blackheart and which may be used with advantage, where at the moment a product much too ductile is being supplied.

After-treatment of Whiteheart Malleable Iron

The fact that the gaseous treatment is carried out in a furnace unhampered by the presence of boxes or packing materials opens up the possibility of being able to heat-treat the material by quenching directly from the furnace without a subsequent heating operation.[6] As the decarburising treatment is normally carried out at 1,050 deg. C., quenching can be done from this temperature or the material can be cooled to some lower temperature and quenched. Quenching may be done in still air, air blast, oil or water. A word of caution should be added here, inasmuch as, if the carbon content greatly exceeds 0.9 per cent. in any section, then an intermediate cooling rate from 1,050 deg. C. will give network cementite and consequent brittleness. The cooling must either be rapid or slow enough to divorce the pro-eutectoid cementite.

FIG. 15.—SECTION OF MANGANESE IRON BAR DECARBURISED AT 1,075 DEG. C. AND WATER QUENCHED. × 60.

The quenching treatments will give some transformation product of austenite, depending upon the rate of cooling and the composition. This, as may well be imagined, opens up a very wide and complex subject which can only be touched upon in this review. It was quite fully investigated in connection with track link castings, and it is only possible here to review briefly some of the results and its possibilities. For complicated castings varying considerably in section, it was found that both oil and water quenching were too severe to ensure a complete absence of cracking, but castings of regular section could be treated in this manner without cracking. The structure obtained in castings containing over 0.4 per cent. C. was a mixture of martensite and troostite, and a subsequent tempering operation at 650 deg. C. would render the structure mainly sorbitic, the castings being extremely tough and having a Brinell hardness of the order of 275.

It was found that castings of regular section could be water quenched and withdrawn from the quench just below the Ar_1 point, say 650 deg. C., and they would then "self-temper." This treatment produced no cracking, but is, of course, mainly applicable to material of uniform section, otherwise there would be a different rate of cooling in sections of different thickness. The hardness of the section was 284 V.P.N. by quenching from 1,050 deg. C., followed by tempering at 700 deg. C. Air-blast cooling was found to be the

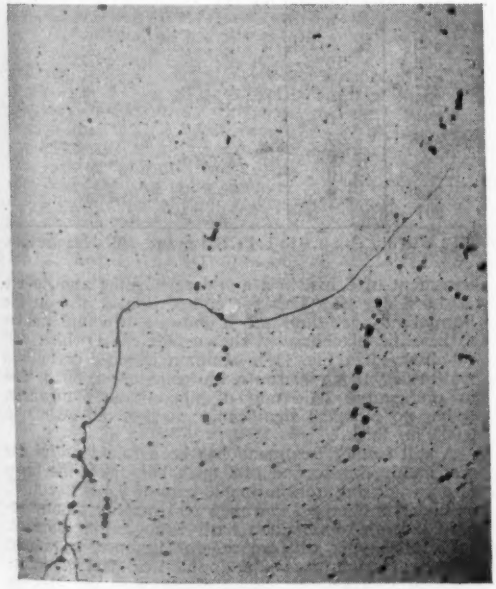

FIG. 16.—SAME AS FIG. 15, BUT DECARBURISED 45 HRS. AT 1,075 DEG. C.

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most effective for castings of complicated section, and by quenching direct from the malleablising temperature a mainly sorbitic product was obtained which was completely converted to sorbite on tempering at 700 deg. C. Fig. 9 shows a micrograph of a typical structure obtained. This product had the virtue of being in the tempered and stress-relieved condition when put into service. Thousands of castings were produced by this method and put into service with eminently satisfactory results. Table IV gives a record of several heats giving test figures, time cycle, etc. It will be noted that the physical properties fall within fairly close limits for this material.

TABLE IV.—*Physical Data of Castings from the Gaseous Process of Annealing.*

Type of Casting.	Time in Hours at Temp.	Time Cycle (Total), in Hours.	Breaking Load (Lb.).	V.P.N.	Deflexion, Deg.	Remarks.
TL 2948–100	20	25.5	12,500	284	7	Air quenched.
TD 507–75	20	25.5	13,690	297	10	Tempered 3 hrs. at 730 deg. C.
TD 507–100	20	25.25	—	281	—	,, ,,
				299		
TD 507–100	20	25.0	—	266	—	,, ,,
				299		
TL 2948–400	20	25.2	13,445	315	7	,, ,,
				334	12	,, ,,
TL 2948–300	20	25.5	13,915	336	9	,, ,,
TD 507–100	20	25.5	—	303	—	,, ,,
TL 2948–400	20	25.5	12,920	307	9	,, ,,
TL 2948–400	20	25.5	11,065	309	5	,, ,,
			13,460	332	10	
TL 2948–320	20	25.5	12,760	272	10	,, ,,
			13,500	295	10	
TL 2948–400	20	25.5	12,000	284	10	,, ,,
			14,800	309	14	
TL 2948–400	20	25.5	11,330	—	10	,, ,,
			14,150		10	
TL 2948–400	20	25.5	10,900	284	9	,, ,,
			12,255	297	7	,, ,,

N.B.—All castings were made to the following specification:—TC 2.9 to 3.1; Si 0.9 to 1.1; S 0.2 and Mn 0.25 per cent.

It has been already noted that it is difficult to lay down any criterion as to what constitutes a good whiteheart malleable casting, as the carbon content, and hence the properties, vary with the thickness of the casting, and they also vary across any section itself, as there is always a carbon gradient in this material, even though it is extremely small in the case of what may be called fully decarburised castings. This carbon gradient may be corrected or neutralised by a diffusion treatment to produce very desirable results for certain purposes. For instance, a casting may contain 1.2 per cent. C in the centre and 0.1 per cent. C at the surface. By stopping the flow of decarburising gas and allowing the atmosphere to come up to equilibrium, the removal of carbon will cease, but diffusion from the core will proceed rapidly at 1,050 deg. C. This will flatten out the carbon gradient, raising the surface carbon to, say, 0.5 per cent. and correspondingly dropping the carbon content of the core. In this way a wear-resisting casting equivalent to a medium carbon steel is produced by the addition of a short diffusion time on to an already short annealing cycle. It can therefore give a product similar to pearlitic blackheart.

Fig. 10 shows the normal structure of a gas-decarburised whiteheart malleable casting which has been given a 40-hr. anneal at 1,050 deg. C. Fig. 11 is another casting annealed for 40 hrs. and then normalised. Fig. 12 is the same casting after a diffusion treatment of 6 hrs. in a non-decarburising atmosphere at 1,050 deg. C. This for comparison is also in the normalised condition, and it shows a structure similar to pearlitic blackheart. The surface effect which will be observed in Fig. 11 is common in gas-decarburised malleable. It is not iron oxide penetration, but is due to preferential oxidation of silicon and manganese. It has no practical significance, as it is only 0.002 to 0.003 in. thick.

A still further treatment has been found useful for moderately thin-section castings. This takes the form of decarburising until a ductile core of 0.4 per cent. C. or under is obtained and then recarburising to any required depth to obtain a hard wear-resisting surface. In certain types of furnace—for instance, a radiant tube gas-fired furnace—the double treatment of decarburising followed by recarburising may be done in one and the same treatment, merely by changing the

furnace atmosphere. An electric furnace would not be suitable for the double treatment, owing to the effect of carburising gases on the heating elements. The photomicrograph, Fig. 13, shows the same casting as in Fig. 11, with the structure produced by recarburising for 1 hr. at 1,050 deg. C.

Effects of Alloys and Composition

The effect of composition has already been alluded to in relation to the rate of breakdown of carbide

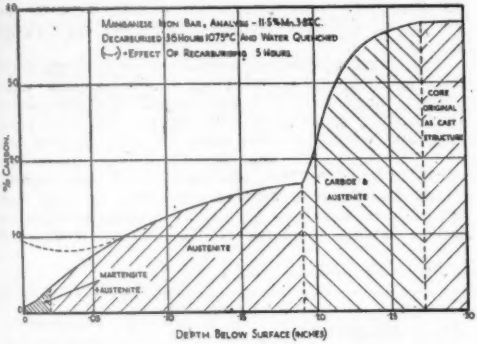
MANGANESE IRON BAR, ANALYSIS - 1.5% Mn, 3.8% C.
DECARBURISED 36 HOURS 1075°C AND WATER QUENCHED
(—)-EFFECT OF RECARBURISING 5 HOURS.
% CARBON.
CORE ORIGINAL AS CAST STRUCTURE
CARBIDE & AUSTENITE
AUSTENITE
MARTENSITE + AUSTENITE
DEPTH BELOW SURFACE (INCHES)

FIG. 17.—CARBON-CONTENT DEPTH CURVE FOR MANGANESE CAST IRON, SHOWING DIFFERENT STRUCTURES AFTER WATER QUENCHING.

and the effect of silicon has been mentioned in this connection. The effect of initial carbon content is not very important, as whiteheart malleable normally runs from 3.0 to 3.7 per cent. C., and in this range the effect of initial carbon will not vary the total annealing cycle more than 10 per cent. In the Author's opinion, this is the normal margin of safety in a decarburising process of this nature and, this being the case, it has not been found to be of any particular importance. Theoretically, however, increase of initial carbon increases the decarburising period, especially for short-cycle material. A vital factor, however, is the ratio of MN/S. If this ratio be less than 1.7, then the excess sulphur restrains graphitisation in form, which is typical of normal whiteheart malleable.

In the gaseous process, when the hydrogen content of the atmosphere is appreciable, the high-manganese ratio material exhibits some abnormal results as regards physical properties. Elongation and bend tests are normally much lower than the product annealed in iron ore. This phenomenon is apparently connected with the simultaneous presence of hydrogen in the furnace atmosphere and the rosette form of graphite. The bend tests are doubled by giving a hydrogen removal treatment, but are still not equal to the iron-ore treatment. Tests were carried out on standard bend test-bars from the same cast and, after malleablising, they showed a bend of 48 deg. By reheating to 800 deg. C., and slow cooling to 200 deg. C., the bend-test figures were increased to 90 deg. When high-manganese material is annealed, rapid breakdown of carbide occurs and graphite particles are precipitated early in the cycle.

The number and size of graphite particles gradually decreases as decarburisation progresses, owing to the impoverishment of the austenite in carbon due to diffusion to the surface and solution of the graphite so as to re-saturate the austenite. When graphite is precipitated, there is an expansion due to the increase in volume caused by formation of the graphite. When the graphite dissolves again, a spongy or porous area is left behind. This is just visible under the microscope, and it is always found in decarburised grey iron. It is well known that hydrogen will diffuse rapidly through iron at annealing temperatures. It is possible that the hydrogen diffuses into these cavities, forming molecular hydrogen, preventing the contraction and sealing of these pores by diffusion. This appears to be a reasonable postulation, since in the iron-ore process these pores appear to seal themselves completely. Further tests are being carried out in gaseous atmospheres free from hydrogen to see whether this defect is absent as it is when the Mn/S ratio is below 1.7.

The majority of whiteheart castings are made with this lower ratio, and this effect is non-existent, as the graphite nuclei in the first place do not readily form except in the heavier sections and, when formed, they persist, since decarburisation does not proceed very far in sections exceeding ½ in. If graphitisation takes

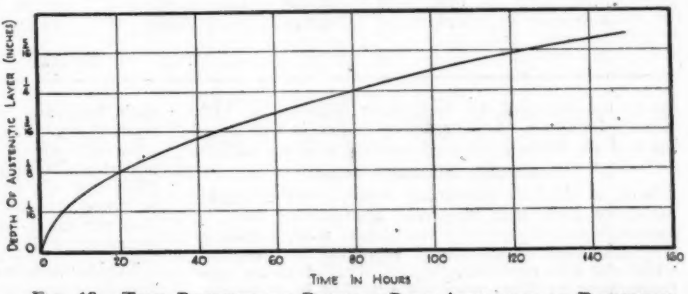

FIG. 18.—TIME REQUIRED TO PRODUCE PURE AUSTENITE AT DIFFERENT DEPTHS FROM SURFACE (AT 1,075 DEG. C.).

place early in the cycle in a light section owing to a high Mn:S ratio, then the rate of decarburisation is also retarded, since graphite is not as readily removed as carbon in solution. In fact, the delayed decarburisation is probably due to the time lag required for the

Annealing of Whiteheart Malleable Iron

graphite to go into solution to resaturate the austenite. Fig. 14 shows four sections of high-manganese whiteheart from the same ½-in. bend test-bars after decarburising for 24, 46, 70 and 100 hrs. Complete graphitisation to the rosette form is noted at 24 hrs., and the gradual disappearance of the graphite particles as the cycle proceeds is also evident. The graphite is coarse and the Mn:S ratio for this material was 1.88.

Before passing to high-alloy irons, it is interesting to note that white irons have been annealed by the gaseous process with up to 0.8 per cent. Cr and 0.25 per cent. Mo. The elements were added so as to give high strengths after subsequent heat-treatment. Standard tensile test-bars cast in this material and oil quenched and tempered at 650 deg. C. gave ultimate strengths of 44 to 46 tons per sq. in. with 8 to 10 per cent. elongation on 2 in. Normally chromium causes difficulty in existing practice and, although it might not show inferior results on bend test-bars which are fully decarburised, it will restrain or even inhibit graphitisation at normal annealing temperatures, but castings up to 0.2 per cent. Cr have been annealed at 1,050 deg. C. for cycles of the order of 25 hrs. in sections of up to 1 in. without showing residual primary carbide.

Austenitic Malleable Irons

With a view to producing decarburised austenitic malleable irons with properties approaching those of austenitic steels, especially manganese steel, a process[8] was originated which aimed at taking an austenitic white cast iron containing Mn, Si, S and P in the same proportions as those normally specified in manganese steel, but with a carbon content of 3.0 to 4.0 per cent. This material was to be decarburised by a gaseous process until the core contained no free carbide, and the material at the centre was wholly austenitic. At this stage there would be a carbon gradient through the section and the surface layers would be low in carbon, and the structure there mainly martensitic. To redress this carbon gradient, the material was to be gas carburised till the carbon content for practical purposes was relatively uniform through the section, and the structure therefore wholly austenitic, giving a material which physically and metallographically was almost identical with austenitic manganese steel.

Test-bars in manganiferous white cast iron made from a small electric arc furnace and decarburised in an atmosphere of partially burnt town's gas showed that the process as originally conceived gave the results predicted. The optimum results on these "as-cast" test-bars, ½-in. dia., decarburised for 30 hrs. at 1,075 deg. C., recarburised for 6 hrs., were 42 tons per sq. in. ultimate strength and 33 per cent. elongation on 2 in.

Tests were afterwards carried out on a single decarburising treatment eliminating the subsequent recarburising operation, as it was thought that the martensitic surface structure would improve the wear resistance and would give the same effect as regards wear as a fully austenitic structure which had already been work-hardened. The elimination of recarburising would also dispense with an operation. A large number of heats were cast on a small production scale and service castings were made. Test-bars were cast with each heat and the composition varied considerably from 11.9 per cent. Mn to 19.2 per cent. Mn. Table V gives the physical properties of standard "as-cast" test-bars after having been decarburised for 21 hrs. at 1,075 deg. C., followed by water quenching. It will be noted that the results show an average of about 32 tons per sq. in. ultimate stress and 25 per cent. elongation on 2 in.

TABLE V.—*Physical Properties of Austenitic Malleable Iron.*

Initial C, per cent.	Si, per cent.	S, per cent.	P, per cent.	Mn, per cent.	Ultimate Strength, Tons per sq. in.	Elongation on 2 in.
3.94	0.93	0.014	0.089	16.15	31.8	22
3.80	1.28	0.002	0.108	15.70	29.8	25
3.95	1.34	0.004	0.111	16.55	32.9	26
3.73	0.76	0.010	0.100	14.30	30.8	23
4.00	0.67	0.010	0.078	15.50	35.6	29
4.08	0.88	0.014	0.072	12.00	32.0	24
3.89	0.84	0.016	0.078	13.10	31.6	25
3.82	0.81	0.014	0.087	14.30	33.2	20
3.94	0.82	0.020	0.080	11.90	33.6	25
4.08	0.93	0.016	0.083	19.20	34.4	30
				Average ..	32.5	24.9

Typical microstructures obtained by a single decarburising treatment are shown in Figs. 15 and 16 (kindly prepared by B.C.I.R.A.). The former is a test-bar treated for 25 hrs. at 1,075 deg. C. in burnt town's gas, whilst the latter is a similar bar treated for 40 hrs. Both were, of course, water quenched after treatment. In Fig. 15 a small amount of martensite is visible in the surface layers backed by a fully austenitic structure, whilst in the core is some primary carbide. Fig. 16 shows the total removal of carbide with a much wider

martensite zone and a thin layer of another phase which contains ferrite and manganese oxide, which is caused by the preferential oxidation of the manganese, due to the fact that MnO has a much lower oxygen dissociation pressure than FeO, and therefore requires higher CO/CO_2 and H_2/H_2O ratios to prevent oxidation of manganese than does iron. This layer has no practical significance, as its maximum thickness is 0.005 in.

The surface hardness of the martensitic surface averages 370 V.P.N., whilst the manganiferous austenite gives an average of 220 V.P.N., which is the same as manganese steel. What is probably more important is that the rate of work-hardening of the decarburised material, which has a carbon gradient, is more rapid than that normally experienced in manganese steel, since the austenite is more unstable due to its lower carbon content. The following tests on the rate of work-hardening or decarburised austenite illustrate this point.

TABLE VI.—*Hardness V.P.N. After Work Hardening by Compression.*

	0 per cent.	7½ per cent.	15 per cent.	30 per cent.
Undecarburised austenite	236	261	292	446
Decarburised austenite..	357	514	488	525

The structures obtained on decarburising followed by water quenching can be correlated with the carbon content for any particular analysis. Fig. 17 is a carbon content depth curve for a certain composition, and was obtained by analysing turnings at various depths. The effect of recarburising for 5 hrs. at 1,000 deg. C. is shown dotted. Fig. 18 is a curve showing the time required to obtain an austenitic structure at different depths from the surface. For instance, it will be seen from the curve that it takes 20 hrs. to remove all free carbide from a ½-in. section at 1,075 deg. C. It will be noted from this curve that the process is quite suitable for the production, within reasonable time cycles, of castings having sections of up to ¾ in., or even 1 in., by leaving a little carbide in the core which does not greatly impair the physical properties.

For heavier castings other compositions have been developed[3] having higher silicon contents (1.5 to 4.0 per cent.), with the addition of Ni in amounts up to 5 per cent., and this renders the core ductile by producing graphitisation. The subject of the production of austenitic malleable irons is too wide to be discussed in detail in this Paper, but sufficient has been said of the results obtained to indicate its possibilities for the production of light intricate wear-resisting castings which, owing to their initial martensitic surface and their greater rate of work hardening, can give better resistance to pure wear than manganese steel.

REFERENCES

[2] British Patent Application No. 16493/42.
[3] British Patent No. 565,887.
[4] British Patent No. 565,946.
[5] British Patent Application No. 17313/43.

(*To be continued.*)

SHEFFIELD ROLL TURNERS

NATIONAL TRIBUNAL'S AWARD

The National Arbitration Tribunal have issued their award (No. 730) on a claim for the payment to roll turners in the Sheffield district (employed by members of the Sheffield and District Engineering Trades Employers' Association and the Sheffield District Rollers, Tilters and Forgers Employers' Association) of rates of wages comparable with those paid to roll turners within the iron and steel industry.

Among the points submitted to the Tribunal were: The contention of the employers' associations that the roll turners in Sheffield have always been subject to rates and conditions applicable to fitters in the engineering industry; the payment to the roll turners concerned of the existing minimum basic rate of 73s. 6d. per week of 47 hrs., plus the 8s. a week differential which applies to skilled maintenance workers in the engineering industry, and 25s. 6d. national bonus; the minimum basic rates and other payments negotiated by the British Roll Turners' Trade Society with other employers and associations in various districts; the contention of the Society that there is no difference in the standard of ability of roll turners in Sheffield and elsewhere throughout the country and that in pre-war days there was interchangeability between districts; and the view of the employers' associations that as the steel produced in Sheffield is not the type produced in the heavy iron and steel trade, wages and conditions negotiated for that trade are not applicable in the Sheffield district.

The Tribunal awarded that: "The minimum basis of total remuneration of roll turners in Sheffield shall be not less than the minimum basis of total remuneration of roll turners in Warrington, as provided under the terms of the agreement negotiated by the British Roll Turners' Trade Society with certain employers in Warrington dated November 23, 1937. The working out of the details of total remuneration on this basis and the fixing of an early date thereafter for the operation of the new rates are matters which, in the view of the Tribunal, could best be settled by negotiation between the parties, and they are referred back to the parties for this purpose. If no agreement is reached between the parties within a period of eight weeks from the date hereof, it would be open to either party, if they so desired, to bring the question again before the Tribunal under the present reference."

B.C.I.R.A. ELECTS NEW MEMBERS

The following firms have been elected to membership of the British Cast Iron Research Association, the name of the official representative being given between brackets:—Anglo-American Corporation of South Africa, Johannesburg (Mr. F. A. Rogers); Barnards, Limited, Norwich (Mr. P. M. R. Bower), and Cross Foundry & Engineering Company, Limited, Gorseinon, South Wales (Mr. W. S. Williams).

PROGRESS AT A LETCHWORTH STEEL FOUNDRY

In the last few years, very commendable progress has been made through the reorganisation of the foundry opefated by K. & L. Steelfounders & Engineers, Limited, at Letchworth. Our representative, revisiting the foundry after an interval of some three years, was impressed by the striking improvement in the ventilation. There has been installed a system by which at numerous points, through louvres, either warm or cool air is introduced in a steady stream, which implies that the rush is restrained and does not create the effect of a draft. Other foundries have spent more money with less satisfactory results, and the management is to be congratulated on having won through with what often proves to be a problem difficult of solution.

Then for the blowing of the Tropenas plant, control by the "invisible eye," has been perfected, and is the subject of a short Paper by the firm's chief metallurgist, Mr. S. T. Jazwinski, to the Iron and Steel Institute. A real effort has been made to improve transport and handling, and a well-equipped concrete pathway now traverses the foundry from end to end. This was a task of major dimensions, as it involved the removal of many hundreds of tons of sand. At the side of this pathway, an underground belt conveyor system has been installed. Along its length are spaced a series of gratings to serve as knock-outs. It is quite noticeable that an intensive effort is constantly being made to eliminate as far as possible the need for dried sand work. This conveyor then serves the plant for production of green sand. It spills its load on to a short length of belt runway over an electro magnet for the removal of spriggs and tramp iron. The iron-free sand is taken by a bucket elevator to feed a rotary riddle, which eliminates hard c re and other extraneous matter. A second bucket elevator feeds a new type of cascading sand cooling machine by Newton Collins, Limited, of Birmingham. A high output August-Simpson mill completes the installation.

Moulding Facilities

For moulding, a number of heavy-duty plain jar rammers by Pneulec, Limited, have been installed, whilst the smaller machines are experimentally being served by a network of roller conveyors. For the operation of the sand plant there is a very well designed switchboard housed in a separate cabin. Here provision is made for the proper isolation of the sections of the plant when under repairs; for ensuring the proper sequence in starting up, and for the instantaneous shutting down of the plant in case of emergency. This last feature is supplemented by additional emergency stop switches situated around the plant.

The mould-drying stoves have been re-sited at the opposite side of the foundry. Naturally they have been improved—especially as to insulation. Then for heat-treating of steel castings, a new semi-automatic electric furnace is now available. The operation is such that the controls when once set by the laboratory are incapable of being altered by the furnaceman. The predetermined cycle is shown by the automatic recorders to be remarkably well followed.

The Paper on the "Gating and Feeding of Steel Castings," given by three members of the staff of K. & L. Steelfounders & Engineers, Limited, at the recent annual meeting of the Institute of British Foundrymen, gave obvious evidence of the existence of a high-grade research department. A tour through the foundry confirms one in this surmise, yet our representative was genuinely astonished to see the great changes which had taken place since his last visit.

Research Developments

A great new department has come into being. On the ground floor provision is made for lorries to back in the building and for the unloading of large-sized specimens. The various rooms and passage ways are either tiled or finished in dust-proof material. The corridors are channelled so as to carry all the service piping for water, electricity compressed air, and the like. The sections already functioning include the normal methods of mechanical testing; chemical and spectrographical analysis, macro and microscopical work; X-ray (both medical and industrial sets are available—the former because research for pulmonary diseases is also being conducted in collaboration with one of the Ministries), two dark rooms, supersonic apparatus for the detection of cracks, and sand testing. It is probably the best laid out and equipped research laboratory solely devoted to the control of and improvement in the technique of the production of steel castings in the country.

We acknowledge with sincere thanks the many courtesies shown to our representative by Mr. F. W. Rowe, Mr. J. Randle, Mr. S, T. Jazwinski, and Mr. Derek Wells, and regret that space prevents us at the moment from giving a more adequate description of the innovations indicated.

PIG-MACHINE MOULDS

Coating for pig-machine moulds requires special material. When a mould burns, the source of the trouble is the coating and its method of application. Cracked moulds usually are attributed to the coating, method of water-cooling the moulds, mould analysis and design, or a combination of these, says H. P. Bailey, writing on the subject in "Steel." Elimination of stickers, he states, is accomplished by the use of a coating having satisfactory adhesive and insulating properties uniformly applied across the face of the mould. Common practice in the case of non-merchant iron is ¼ in. Smooth-top pig-iron is obtained by using a mould coating free from gases. Hot metal should have little or no affinity to react chemically with the coating. Satisfactory mould life is considered to be about 250 tons of pig-iron per mould.

LANCASHIRE FOUNDRYMEN ELECT NEW OFFICIALS

WORK OF THE TECHNICAL COMMITTEE

Mr. A. Hopwood (Liverpool), branch-president, took the chair at the annual general meeting and election of officers of the Lancashire branch of the Institute of British Foundrymen, held in the Engineers' Club, Albert Square, Manchester. After the minutes of the annual meeting held during April, 1944, and the balance sheet had been approved, the hon. secretary, Mr. H. Buckley (Burnley), presented his annual report, in the course of which he said that the attendance at branch meetings this session had been of the order of about 80; yet this was inadequate. The session, which had been extended to cover nine months out of the year, started off very well with a works visit to Thomas Robinson & Son, Limited, Rochdale, and was enjoyed by all who attended. The Papers read this session had been of the highest quality and, from a practical point of view, the best for many years, and must have satisfied the most critical of those members who ask for practical Papers by practical men.

Membership

Membership had been increased during the year by only 27; actually the total number of new members was 38, being made up of two subscribing firms, 15 members, 17 associate members, two associates and two students. Against this the branch lost two members by death, Mr. W. Potts, of Manchester, a member since 1918, and Mr. G. M. Priestley, who was the winner of the short Paper competition last session. This increase of new members was unsatisfactory, though it was realised that it is not numbers alone that ensured success, but rather the effort and enthusiasm exercised by the individual member.

Referring to the balance sheet, it was pointed out that each meeting cost £9, which included postage, printing, lecture hall and typing.

The Burnley section had again had a normal session of five meetings, with attendances quite up to standard, but it was reasonable to expect an increase as soon as normal conditions returned to the country.

The social activities were again very successful, and the Council was planning a quick return to pre-war custom. In conclusion, Mr. Buckley thanked all members of the Council for their help, and in particular Mr. Harper for his assistance.

The report having been adopted, MR. A. PHILLIPS (Manchester), the representative for the Lancashire branch on the Technical Committee, explained that the work was done entirely upon a voluntary basis. Any member of the branch who was interested in any particular form of foundry practice, and who could render assistance for investigation purposes, was invited to send suggestions forward to the hon. secretary.

In the case of the old Technical Committee, there were sub-committees covering cast iron, non-ferrous, sands, and refractories. It had now been decided that specific work should be investigated by people who would be specially nominated for the purpose.

The first sub-committee was the T.S.1, and was the Mechanical Development Sub-committee. The second sub-committee dealt with defects in casting. The third committee dealt with basic cupolas. The fourth was the Grey-iron Test-bar Committee and formulated or recommended the best methods of producing grey cast-iron test-bars as specified in B.S. 21 and B.S. 26. The T.S.4 Sub-committee dealt with malleable cast iron and had opened negotiations with the Malleable Cast-iron Sub-committee of the British Cast Iron Research Association regarding a revision of the B.S.S. 309/410. The T.S.6 Sub-committee had a control test for cast iron. The terms of reference for this committee were to make recommendations on forms of test applicable to molten grey cast iron before pouring into the mould. This might be considered as a very interesting piece of work, and it would take a long time to complete investigations.

T.S.7 dealt with moulding materials for iron casting, and there might be a report to the Technical Council on the possibility of carrying out an investigation on the soundness of moulding materials and on the soundness of grey and malleable grey-iron castings. Non-ferrous and light alloy castings might be added. The T.S.9 Sub-committee dealt with defects in cast-iron castings, and would prepare a list of defects with a view to sectional publication. The T.S.10 Sub-committee dealt with basic cupolas and their possibilities. The T.S.11 Sub-committee dealt with gases in cast iron, and would explore the present state of knowledge of the effects of gases in cast iron. They would report to the Technical Council as to whether any further work could be usefully done.

The T.S.12 Sub-committee dealt with dimensional tolerances in casting, which had always been a bogey as between sellers and buyers, and especially so with some present-day engineers. The T.S.13 test dealt with the testing of oil sand and a recommendation of a procedure to be adopted.

In addition, the Technical Council would decide who should be the people selected from the Institute as suitable representatives on the various sub-committees, such as the B.S.I., the Admiralty, the A.S.D. and the D.T.B.

Ministry of Supply Proposal

The Ministry of Supply had stated they proposed to institute a new method of testing their cast iron for their own particular purpose with respect to fighting vehicles. They had already commenced to establish a formula of what they considered to be the best way to effect a test, cutting a piece out of each casting and testing it as representing the bulk of the casting. The Institute fought this idea, having a representative on the committee, and certain people had been nominated to meet the Ministry. It was hoped eventually that the Institute would be able to establish what they themselves considered to be the best method to adopt from the point of view of foundrymen.

Quite recently the D.T.D. and A.I.D. people, in the name of the Institute, wanted a different method of making a light alloy bar instead of having a separately

(*Continued overleaf, column* 2.)

RESTORING DESTROYED PORTS

After the triumphs of ingenuity represented by "Mulberry," "Pluto" and "Fido" comes news of "Shark," the designation applied to the scheme for restoring coastal ports destroyed by the enemy. It was not necessary to complete the scheme, as the Germans in their retreat failed to carry out demolitions on the scale anticipated; nevertheless "Shark" provides another striking example of the way in which private enterprise, represented by British structural steelwork firms and civil contractors, evolved a successful solution of a vitally important problem.

Floating Steel Caissons

The basis of the scheme was the construction of floating steel caissons in units which could be transported to the Continent and used rapidly to seal locks and dock entrances wrecked by demolitions. Dorman, Long & Company, Limited, who had been responsible for a vital part of the "Mulberry" project, were called upon by the Ministry of Supply to undertake this work.

The company had to produce 151 large and 151 small complete units involving 10,000 tons of structural steel, 3,000 tons of timber, and a large amount of ancillary equipment. Dorman, Long sought the assistance of 15 structural steelwork firms and three civil contractors as sub-contractors, so that the work could be completed in the short time available.

The floating steel caissons were composed of units each 30 ft. in height by 7 ft. in width and 40 ft. in length. These units were bolted together and enabled the greater part of a damaged dock entrance to be closed. The openings between the caisson sides and the dock entrance walls were closed by heavy timber flaps reinforced with steel and hinged on the outer units, the pressure of the impounded water retaining these flaps against the mills.

At high tide a ship could enter the dock; the caisson was floated into position and sunk by flooding. To open the dock the caisson was made buoyant by blowing out the water by means of compressed air. Either operation occupied only 90 mins.

Prefabricated Units

The large units of the caissons were prefabricated in various parts of the country, while a virgin site on a tidal river was prepared for the construction of the caissons. In 16 weeks roads, railways and reinforced concrete rafts covering three acres were laid; launchways and a fitting-out dock constructed; electric, water and compressed-air services installed. Twelve cranes up to 30 tons capacity, welding and other special plant were erected. Mass production was begun, and the end of the first day saw a 60-ton unit travel along the track to be welded. Other operations, including installation of fittings, testing to prove the units watertight, painting and launching, followed, nine days being occupied to complete the work. The scheduled output of one unit a day was achieved, but only one-third of the original number had been completed when Shaef decided that the full programme was not necessary, and production ceased.

FOUNDRY APPRENTICESHIP SCHEME

A 16-page booklet has been issued to outline to boys and their parents a straightforward scheme created by the Nuffield Organisation for the teaching of all branches of the foundry craft during a four- or five-year period. A curious feature is that "[patternmaking] offers a most interesting career to a young man and youths who have completed their training under the foundry apprenticeship scheme and who wish to take it, will find the general knowledge of foundry work thus gained during apprenticeship of great value . . ." Surely this would leave it a little late in life to serve what really amounts to a second apprenticeship. The theoretical side of the work is stressed throughout the pamphlet, and a day each week has to be spent at a technical college. This, of course, will be the general rule for all trade lads in the future.

For the brightest boys there is the prospect of a £250-a-year scholarship to a University, but this is only if they change over to the engineering apprenticeship course! It is to be hoped that this will only mean a "judicial separation" and not a "divorce." The general scheme is for the lads to spend six months in the following sections:—Patternshop; coreshop, core inspection; green sand moulding; mould assembly; laboratory; melting and casting; fettling; casting inspection and machine shop.

Copies of the scheme may be had by writing to the Apprentice Supervisor, Morris Motors, Limited, Engines Branch, Coventry.

LANCASHIRE FOUNDRYMEN ELECT NEW OFFICIALS

(*Continued from previous page.*)

cast forged bar. They wanted to cast the way they liked to specify. Several people, including himself, said Mr. Phillips, were conducting an inquiry into the matter and would eventually submit to the Institute what they considered to be a practicable procedure for obtaining the best results. The Technical Council asked everyone who was interested in any of the subjects dealt with by the sub-committees to write to them either for the purpose of imparting or receiving information. All the members serving upon the sub-committees were giving their services quite freely and the work they were doing was entirely for the benefit of the members of the Institute as a whole.

A vote of thanks, proposed by Mr. Jackson and seconded by Mr. Holland, was carried by acclamation.

A vote of thanks was then accorded to the retiring officers.

The following office-bearers for 1945-46 were elected:—*President*, Mr. Stanley Brooks; *vice-presidents*, Mr. W. Brown (Bramhall) and Mr. R. R. Hargraves; *hon. secretary*, Mr. H. Buckley; *hon. treasurer*, Mr. F. A. Harper; *members of Council*, Mr. W. Brown (Liverpool), Mr. A. Jackson, Mr. G. C. Studley, Mr. R. C. Hargraves and Mr. R. S. Yoemans; *representatives on General Council*, Mr. W. N. Cook, Mr. W. Holland, Mr. A. Hopwood and Mr. J. Jackson; *hon. auditors*, Mr. H. Booth and Mr. D. Fleming; *representative on the Technical Committee*, Mr. A. Phillips.

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STANTON MACHINE CAST PIG IRON

SPECIFICATION

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Length	22 inches
Width	8½ inches
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(at notch 2½ inches).

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STANTON, HOLWELL & RIXONS BRANDS

THE STANTON IRONWORKS COMPANY LIMITED NEAR NOTTINGHAM

NEWS IN BRIEF

THE LONDON OFFICE of the Harland Engineering Company, Limited, is now Harland House, 20, Park Street, W.1.

LONDON METAL WAREHOUSES, LIMITED, have recently opened a sales warehouse and showroom at 306, Deansgate, Manchester.

I. BIER & SON (IRON & STEEL), LIMITED, announce that their head office is now at Bevois House, 27-30, Basinghall Street, London, E.C.2.

THE DIRECTORS of the Harland Engineering Company, Limited, propose to increase the nominal capital from £300,000 to £350,000 by the creation of 200,000 5s. shares.

A FORTNIGHT AFTER it crashed through the bridge carrying the Great North Road over the River Ure at Boroughbridge, an 85-ton casting was recovered from the river.

A NEW RECORD for Immingham, near Grimsby, was set up recently by the arrival of 12,000 tons of iron ore from Sweden, the biggest single cargo of iron ore to reach the port.

SO LONG AS it does not interfere with war priority contracts, the manufacture of cast-iron bath tubs by American producers has been freed from control. Other products similarly freed are electric ranges and cooking appliances, heating stoves and passenger motor-cars.

DURING THE YEARS 1939 to 1944, inclusive, Harland & Wolff, Limited, together with a subsidiary shipbuilding company, produced 1,052,416 gross tons of naval and merchant vessels. During the same period the company produced machinery with a total indicated horse-power of 1,329,235.

THE INDUSTRIAL & COMMERCIAL FINANCE CORPORATION, LIMITED, whose formation with total resources of £45,000,000 was announced earlier this year, has now been registered and the board of directors appointed. The board will consist of Mr. W. Piercy (chairman), Mr. Edward de Stein, Mr. W. H. Fraser, Lieutenant-Col. Lord Dudley G. Gordon, the Earl of Limerick, Col. G. K. M. Mason, Mr. R. H. Roberts, and Mr. C. M. Skinner.

THE ANNOUNCEMENT by the chairman of Rolls-Royce, Limited, that the works at Hillington, Glasgow, would be continued, confirms previous statements, writes our Glasgow correspondent. The personnel was to be reduced at the beginning of 1945, but there have been very few pay-offs and all the factories are on full production. There are now vacancies for more than 1,000 men, so that mechanics leaving the Forces can get a job with Rolls-Royce, Limited, if they are interested in and adapted for engineering.

THE NORTH WESTERN FUEL LUNCHEON CLUB has been formed and organised to function on generally similar lines to the London Fuel Luncheon Club. Sir Frederick West, K.B.E., J.P., is the first president. Providing reasonable support is forthcoming, the committee will proceed to complete all arrangements for commencement of activities of the club, including a full programme of luncheon meetings and speakers for the coming session. The first luncheon meeting provisionally is fixed for October. Full details are available from Mr. R. Baker, M.Inst.F., Selas Works, City Road, Manchester, 15, the hon. organising secretary.

SIX POINTS FOR INDUSTRY were outlined by Mr. E. C. Gordon England, speaking at Newcastle-upon-Tyne at a meeting of the Northern branch of the Engineering Industries' Association. These were:—Restoration of industry's right to recruit labour; prompt settlement of all outstanding war contracts; a fixed date for the repayment of E.P.T. credits; all money spent on research to be free of income-tax; publication of the full facts of the material position; and particulars of the order of priority in industry. Mr. England said that it would be foolish to think that the change-over from war to peace would be smooth and efficient.

A TABLET TO COMMEMORATE the work of the late Sir William Bragg, O.M., and of his son, Prof. Sir Lawrence Bragg, presented by Mrs. Smithells, widow of Prof. Arthur Smithells, was unveiled by Prof. R. Whiddington, F.R.S., at Leeds University, recently. The tablet states: "Near this place in the old Physics Laboratory in the year 1913 William Henry Bragg, Cavendish Professor of Physics in this University from 1909 to 1915, and his son William Lawrence Bragg, began their joint researches and established with the first X-ray spectrometer the nature of X-ray spectra and the principles of crystal analysis for which they were awarded the Nobel Prize in 1915."

THE DIRECTORS of Darwins, Limited, in their annual report, state that in the early part of the financial year there was a general cancellation of war contracts. An immediate changeover to export business to counterbalance the decreased war demand could not, unfortunately, be accomplished, owing to Government restriction of export permits. In normal times export business forms a substantial part of the company's turnover. The incidence of increased wages and coal costs during the last five years has, in addition, had an adverse effect, inasmuch as since 1940 no increase in selling prices of certain classes of steel has been permitted by the Iron and Steel Control. These adverse causes have resulted in a decline in turnover and profits.

IN A STATEMENT circulated with the report and accounts of the Zinc Corporation, Limited, Mr. John R. Govett, the chairman, says that the great mining field of Broken Hill, in which they occupy a very prominent position and its associated smelting works at Port Pirie, have made available since the war over 1,150,000 tons of pig-lead for use by the Allies. The output of silver was in the neighbourhood of 40,000,000 ozs. In addition the concentrates produced at Broken Hill shipped to smelters or treatment works represented over 700,000 tons of recoverable zinc metal. The value of this contribution to the Allied cause cannot be over-estimated, Mr. Govett continues. The European war could not have been won nor the Pacific war waged without it.

Why wait

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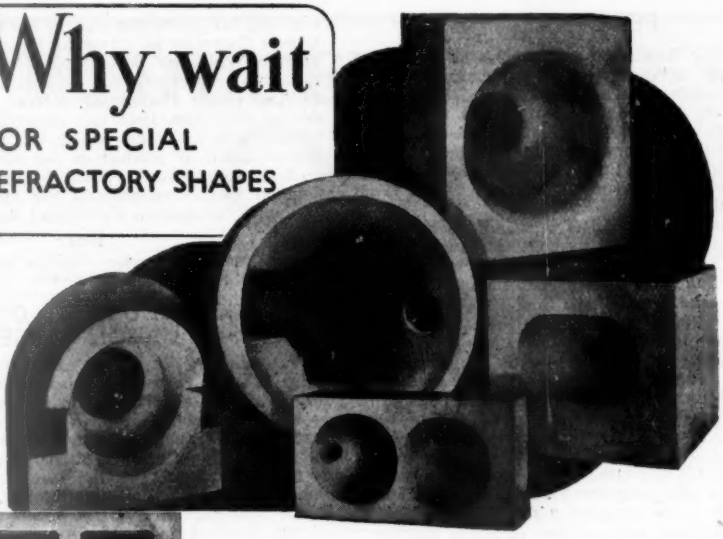
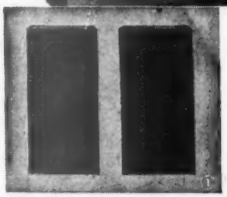
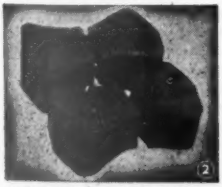
REFRACTORY SHAPES





NO SHRINKAGE. Illustration (1) shows two blocks cast in moulds and dried at atmospheric temperature. One was fired to 1500° C for four hours. Specimens are the same size.

STRENGTH. Illustration (2) shows two test pieces cast in moulds, dried at atmospheric temperature and one heated to 1000° C. Tensile strength —*Unfired*, 550 lbs. per sq. in. *Fired*, 1312 lbs. per sq. in.



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Make them quickly and economically

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REFRACTORY CONCRETE

IN CASES of emergency, special shapes and replacements may be made quickly with Durax No. 2 Refractory Concrete. Mixed similarly to ordinary building concrete, Durax is poured into position, dries quickly and sets to a remarkable degree of hardness. There is no permanent volume change and tests have shown no signs of fusion below 1580° C—there is no tendency to crack or spall. Durax No. 2 is used for protection of header tubes and drums in water tube boilers, access door and lid linings, flame baffles, burner blocks, furnace and coke oven door linings, complete monolithic linings, small monolithic arches and all types of special shapes.

General Refractories
LIMITED

GENEFAX HOUSE SHEFFIELD, 10, ENGLAND.
TELEGRAMS: "GENEFAX, SHEFFIELD"

GR

33

PERSONAL

SIR FREDERICK REBBECK has resumed the chairmanship of Harland & Wolff, Limited. He vacated it temporarily in 1943 to concentrate on vital matters of production, but retained the managing directorship.

MAJOR H. C. STEWART, Royal Armoured Corps, has been awarded the Military Cross for distinguished service in North-Western Europe. He was associated with the Grahamston Iron Company, Limited, Falkirk, before the war.

MR. WILLIAM BARR, A.R.T.C., chief metallurgist, and Mr. Thomas J. Smith, purchasing manager, both of Colvilles, Limited, Glasgow, have been appointed directors of Fullwood Foundry Company, Limited, Mossend and Hamilton.

MR. A. G. ROBIETTE, M.Sc., who has recently returned from a tour of the Indian metallurgical industries, has resigned his position as chief metallurgist to Birlec, Limited, and has been appointed to a position with H. A. Brassert & Company, Limited, consulting engineers.

LT.-COL. K. C. SHARPE, who has recently returned from S.E.A.C., after nearly four years, will shortly take control of his late father's business, F. F. Sharpe, iron, steel, coke and scrap merchants, of Wolverhampton, which has been managed during his absence by MR. H. WILKES, who will continue to act as manager.

SIR EUGENE RAMSDEN, who received a barony in the King's Birthday Honours, has adopted the title of Baron Ramsden. He is chairman of A. & S. Henry & Company, Limited, Richard Johnson, Clapham & Morris, Limited; deputy-chairman of Thomas Bolton & Sons, Limited; and on the boards of other companies.

MR. W. C. DEVEREUX has arranged to relinquish his position as chairman and managing director of High Duty Alloys, Limited, Slough, in order to devote himself to the scientific development and application of aluminium alloys over a wider commercial field than hitherto. He will retain the chairmanship of International Alloys, Limited.

MR. E. M. FRASER, Director-General of Aircraft Production, has been released from his official duties at the request of Lord McGowan. Previous to joining the Ministry of Aircraft Production in July, 1942, Mr. Fraser was Director of Investigation and Statistics at the War Office, which Department he joined from Imperial Chemical Industries, Limited, in July, 1939.

MR. MARRIOTT HALL, has retired, at his own request, from the sales department of Hadfields, Limited, East Hecla Works, Sheffield. He joined the company, as a boy, in 1900, and can lay claim to be one of the devoted band who aided the late Sir Robert Hadfield to build up the company to its present position. For many years Mr. Hall has supervised the commercial sales of steel castings and the wide knowledge he has gained of castings for railway, dredger, colliery and general engineering works has been of inestimable service to the company.

MR. IAN F. L. ELLIOT, former commercial director of the British Iron and Steel Federation and managing director of the British Iron & Steel Corporation, Limited, has joined the staff of the United States Steel Export Company as European liaison assistant to Mr. George Wolf, the president of that company. Mr. Elliot was representative of the British Iron and Steel Control in the United States from 1940 to 1942 and during 1943 and 1944 was chairman of the Eastern Group Supply Council, which was responsible for the co-ordination of production for war purposes in the Eastern Hemisphere. Since last November he has handled special assignments for the British Ministry of Supply Mission in the United States.

Will

DOWELL, PERCY, ironfounder, chairman of Dudley & Dowell, Limited, Cradley Heath £47,892

IRON AND STEEL CONTROL LIAISON OFFICES

The Ministry of Supply announce that as from July 31 the following liaison offices of the Iron and Steel Control have ceased to operate:—Middlesbrough; Sheffield; Glasgow, and Birmingham. After that date all matters hitherto dealt with by the liaison officers should be referred to the appropriate Director at the headquarters of the Iron and Steel Control, Ashorne Hill, near Leamington Spa, Warwickshire.

The Sheffield offices of the spring and scrap sections of the Control, and of Iron and Steel Disposals, Limited, and the Alloy and Special Steel Sub-control, will continue to operate from 15, Ranmore Park Road, for the time being. Iron & Steel Disposals, Limited, and the scrap section of the Control at Middlesbrough, will continue to operate from Midland Bank Chambers, Middlesbrough. The Scottish office of Iron & Steel Disposals, Limited, will continue to operate from 116, Blythswood Street, Glasgow, C.2.

The Drop Forging Sub-control and the Midland area offices of the Iron and Steel Control Scrap Department, Iron & Steel Disposals, Limited, and British Iron & Steel Corporation (Scrap), Limited, will continue to operate from 263, Hagley Road, Edgbaston, Birmingham, 16.

RESEARCH IN THE STEEL INDUSTRY

In connection with the recently announced iron and steel extension programme, a new research organisation, the British Iron and Steel Research Association, has been set up. The director of the association is to be Dr. C. F. Goodeve, O.B.E., F.R.S., at present Assistant Controller for Research and Development at the Admiralty, where for the last three years he has been the senior executive covering the research and development for the whole of the naval organisation. It is expected that he will be released from this post to take up his new appointment some time in the autumn.

Before the war, Dr. Goodeve was a reader in physical chemistry at University College, London, and was for many years consultant and technical adviser to various big industry firms. For the first three years of the war, as Commander R.N.V.R., he was one of the Admiralty's leading scientists, playing a prominent part in the defeat of the magnetic mine and of the U-boat.

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From JULY 16th 1945

GENERAL LIGHTING SERVICE LAMPS

COILED-COIL PEARL

Standard Voltages (200-260)

	s.	d.
40 watt	1	6
*60 watt	1	6
*75 watt	1	8
*100 watt	1	10

**Available shortly*

SINGLE COIL PEARL & CLEAR

Standard Voltages (100-130 & 200-260)

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15 and 25 watt	1	3
40 and 60 watt	1	3
75 watt	1	7
100 watt	1	9
150 watt	2	9
CLEAR		
200 watt	4	6
300 watt	8	0
500 watt	10	6

Prices do not include Purchase Tax.

Write for Price List OS 9759 which gives full particulars of all price reductions.

Announcement of The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2

Raw Material Markets

IRON AND STEEL

It has not yet been possible to increase the number of blast furnaces in operation, but better supplies of foreign ore have favourably influenced the output of the furnaces now in blast. The steelworks and foundries are getting adequate tonnages of pig-iron for present needs and the Control may be relied upon to ensure that production does not fall short of the demand. Not improbably, more stacks will have to be started up to provide for the increasing requirements of the light-castings trade, but for the present, at all events, there is no shortage of basic or the special qualities of iron required by the engineering and allied foundries.

British steelmakers to-day are probably supplying bigger tonnages of steel semis for re-rolling than at any time in their history, but consumers' appetite is still unappeased and they are almost as keen to acquire defectives, double sawn, crops, etc. Sheet bars are a No. 1 priority, but billets, too, are wanted in considerable tonnages.

Trade in heavy structural steel is still a dull spot, but a better flow of orders for steel plates has enabled the mills to arrange more satisfactory rolling programmes over the next few weeks. Repairs and renewals of the home railways, and the vast amount of reinstatement yet to be accomplished on the Continent to restore transport to something approaching normal, assure maximum employment for the rail mills, while colliery requisitions for props, arches and roofing bars are on a steadily ascending scale. The sheet trade, however, is still the outstanding feature. Buyers are offering business far in excess of the capacity of the mills, and it is now the rule rather than the exception to indicate delivery dates as far ahead as January or February next.

NON-FERROUS METALS

The non-ferrous metals markets present a dull appearance at the moment. It is hoped, and expected, that the process of releasing the metal trades from wartime restrictions will be continued until the shackles of control are finally removed, but there may be a halt while the new Government is settling in. There is enough copper and zinc available to meet the somewhat restricted needs of the times. There is no lack of orders for finished and semi-finished metal products, and most of the manufacturers have full order-books, but labour is not in sufficient supply. Probably more lead could be absorbed if it were freely available, but light metals such as aluminium and magnesium are relatively plentiful. A simplified procedure for the control of both raw and fabricated light metals has been introduced as from August 1.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Met-Fab, 209, Chester Road, Sunderland—Engineers, etc. £1,000. J. E. and B. Talbot.

Vital (Holloware), 33b, Bedford Avenue, Slough—£5,000. J. R. and S. W. Hunt, and S. F. Dryland.

Lloyd Allen Engineering, 36, Kennedy Street, Manchester—£1,000. H. J. and J. A. Mann, and R. A. H. Johnson.

Always Welding Construction, 1, New Square, London, W.C.2—£1,000. F. C. Rivett, O. L. Mitchell, and G. I. A. Stow.

Fenlow Products, 6, Finch Lane, London, E.C.2—Ironfounders, engineers, etc. £1,000. D. V. Baglow and B. N. Fenton-Smith.

Palace Industrial Corporation, Craven House, Kingsway, London, W.C.2—Founders, engineers, etc. £5,000. J. T. and J. S. Smith.

W. V. Neal & Company (Denton), Iron Street, Denton, Lancs—Brass and aluminium founders. £2,000. L. and W. V. Neal and A. McGregor.

Foamslag (Tees-side Production)—Manufacturers, crushers and treaters of blast-furnace slags, etc. £40,000. Directors to be appointed by Pease & Partners, Limited, and Holland & Hanner & Cubitts, Limited.

MR. WILLIAM HAMMOND, of Wm. Hammond, Blades & Company, ironfounders, of Leicester, died on July 22.

MR. WILLIAM H. PERRY, works manager of the Patent Shaft & Axletree Company, Limited, Wednesbury, until he retired at the end of 1938, died on July 21, at the age of 77. He first joined the company in 1885 and left 15 years later to take up an administrative post with William Whitwell & Company, of Stockton-on-Tees. Messrs. Whitwell's works were closed down towards the end of 1922 and Mr. Perry returned to the Patent Shaft & Axletree Company as works manager.

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